What is claimed is:

1. A ceramic coating for protecting a substrate, comprising

   (a) a ceramic matrix formed by a high temperature interaction between fine vitreous particles and the solid content of a ceramic liquid precursor; and

   (b) a filler comprising one or more materials selected from the group of ceramic, glass, and metal particles, the filler being integrated in the matrix.

2. The ceramic coating of claim 1 wherein the fine vitreous particles are glass particles having an average particle size of 5 μm or less.

3. The ceramic coating of claim 2 wherein the glass particles of the matrix are selected from the group of lithium sodium borosilicate glass and glasses containing SiO_2 Al_2O_3, B_2O_3, P_2O_3, ZrO_2 and TiO_2.

4. The ceramic coating of claim 3 wherein the glass particles of the matrix are lithium sodium borosilicate glass containing up to 10wt% additions of one or more oxides selected from the group of Fe, Ni, Co, V, Sb, P and Mn.

5. The ceramic coating of claim 1 wherein the ceramic liquid precursor is selected from the group of ceramic sols of alumina, silica, titania, zirconia, and mixtures thereof.

6. The ceramic coating of claim 1 wherein the filler material is selected from the group of ceramic particles consisting of alumina, silica, titania, magnesia spinel, B_4C, BN, SiC, AlN, Sialon, and mixtures thereof, and from the group of metallic particles consisting of aluminum, stainless steel, and nickel alloys.

7. A composite coating for protecting a substrate, comprising

   (a) the ceramic coating of claim 1; and

(b) a sealant penetrating at least the surface layer of the ceramic coating.

8. The coating of claim 7 wherein the sealant is an inorganic material derived from a soluble ceramic precursor, the ceramic precursor being selected from the group of sodium borate, boric acid, mixed borophosphates, and, mixtures of ceramic sols and silica sols sodium borate, boric acid, and mixed borophosphates.

9. The coating of claim 7 wherein the sealant is an organic polymer containing at least one resin selected from the group of polytetrafluoroethylene, tetrafluoroethylene-perfluorovinyl ethers copolymers, fluorinated ethylene-propylene copolymers, low density polyethylene, poly ether sulfone, polyimide, and epoxy resins.

10. A method of producing a protective ceramic coating and applying the coating onto a substrate, the method comprising:

(a) forming a preparation by mixing together fine vitreous particles, a liquid carrier, and filler particles selected from the group of ceramic, glass, and metal particles, wherein the preparation excludes a sol;

(b) applying the preparation onto a substrate to form a coating on the substrate;

(c) heating the coating until the coating has sufficient integrity to be coated with a ceramic sol;

(d) applying a ceramic sol onto the coating such that the sol penetrates the pores of the coating; then

(e) heating the coating under conditions sufficient to cause an interaction between the fine vitreous particles and the solid component of the ceramic sol, thereby forming a ceramic matrix with filler particles integrated therein.

11. The method of claim 10 wherein in step (c), the coating is heated under conditions sufficient to provide the coating with enough mechanical strength for dip-coating, then, in step (d) the coating is dip-coated in a liquid bath of the ceramic sol so that the ceramic sol penetrates the pores of the coating.

12. The method of claim 10 wherein in step (a), the preparation is mixed until it is suitable for spraying, and in step (b), the preparation is sprayed on the substrate.

13. The method of claim 10 wherein in step (c) the preparation is heated at between 300-850°C.

14. The method of claim 10 wherein in step (e) the coating is heated at between 550-850°C.

15. The method of claim 14 wherein in step (e), the coating is heated at a temperature between 650-850°C and under conditions sufficient to sinter the coating.

16. The method of claim 10 wherein the fine vitreous particles are glass particles having an average particle size of 5 μm or less.

17. The method of claim 16 wherein the glass particles of the matrix are selected from the group of lithium sodium borosilicate glass, and glasses containing SiO_2, Al_2O_3, B_2O_3, P_2O_3, ZrO_2, and TiO_2.

18. The method of claim 17 wherein the glass particles of the matrix are lithium sodium borosilicate glass including up to 10 wt. % additive oxides selected from the group of Fe, Ni, Co, V, Sb, P, and Mn.

19. The method of claim 10 wherein the ceramic sol is selected from the group of ceramic sols of alumina, silica, titania, and zirconia.

20. The method of claim 10 wherein the filler material is selected from the group of ceramic particles consisting of alumina, silica, titania, magnesia spinel, B_4C, BN, SiC, AlN, Sialon, and mixtures thereof,

and from the group of metallic particles consisting of aluminum, stainless steel, and nickel alloys.

21. The method of claim 10 further comprising after step (e), applying a sealant onto the coating such that the sealant penetrates at least the surface layer of the coating, then, heating the coating at a temperature sufficient to bond the sealant to the ceramic matrix.

22. The method of claim 21 wherein the sealant is in solution form and is applied to the coating by one of dip-coating or spraying.

23. The method of claim 21 wherein the sealant is applied to the coating by one of powder coating, spray-coating, dip-coating, and spin-coating.

24. The method of claim 22 wherein the sealant is an inorganic material derived from a soluble ceramic precursor, the ceramic precursor being selected from the group of sodium borate, boric acid, mixed borophosphates, and, mixtures of ceramic sols and silica sols sodium borate, boric acid, and mixed borophosphates.

25. The method of claim 23 wherein the sealant is an organic polymer selected from the group of polytetrafluoroethylene, tetrafluoroethylene-perfluorovinyl ethers copolymers, fluorinated ethylene-propylene copolymers, low density polyethylene, poly ether sulfone, polyimide, and epoxy resins.

26. A method of producing a protective ceramic coating and applying the coating onto a substrate, the method comprising:

(a) forming a preparation by mixing together a ceramic sol, pH modifier agent, and filler particles selected from the group of ceramic, glass, and metal particles, the sol, modifier agent and filler particles being selected to avoid gelation of the sol;

(b) mixing in fine vitreous particles to the preparation;

(c) applying the preparation onto a substrate to form a coating on the substrate;

(d) heating the coating under conditions sufficient to cause an interaction between the fine vitreous particles and the solid component of the ceramic sol, thereby forming a ceramic matrix with filler particles integrated therein.

27. The method of claim 26 wherein the coating is heated at between 550-850°C.

28. The method of claim 27 wherein the coating is heated at between 650-850°C under conditions sufficient to sinter the coating.

29. The method of claim 26 wherein the fine vitreous particles are glass particles having an average particle size of 5 μm or less.

30. The method of claim 29 wherein the glass particles of the matrix are selected from the group of lithium sodium borosilicate glass, and glasses containing SiO_2, Al_2O_3, B_2O_3, P_2O_3, ZrO_2, and TiO_2.

31. The method of claim 30 wherein the fine glass particles are lithium sodium borosilicate glass that includes up to 10 wt. % additive oxides selected from the group of Fe, Ni, Co, V, Sb, P, and Mn.

32. The method of claim 26 wherein the ceramic sol is selected from the group of ceramic sols of alumina, silica, titania, and zirconia.

33. The method of claim 26 wherein the filler material is selected from the group of ceramic particles consisting of alumina, silica, titania, magnesia spinel, B_4C, BN, SiC, AlN, Sialon, and mixtures thereof, and from the group of metallic particles consisting of aluminum, stainless steel, and nickel alloys.

34. The method of claim 26 wherein in step (c), the preparation is applied to the substrate by spin-coating.

35. The method of claim 26 further comprising in step (a), adding a liquid carrier to the preparation.

36. The method of claim 26 wherein between steps (b) and (c), a liquid carrier is applied to the preparation to dilute the preparation, then in step (c), the preparation is applied to the substrate by one of spraying or dip-coating.

37. The method of claim 26 further comprising after step (d), applying a sealant onto the coating such that the sealant penetrates at least the surface layer of the coating, then, heating the coating at a temperature sufficient to bond the sealant to the ceramic matrix.

38. The method of claim 37 wherein the sealant is applied to the coating by one of powder coating, spray-coating, dip-coating, and spin-coating.

39. The method of claim 37 wherein the sealant is an inorganic material derived from a soluble ceramic precursor, the ceramic precursor being selected from the group of sodium borate, boric acid, mixed borophosphates, and, mixtures of ceramic sols, sodium borate, boric acid, and mixed borophosphates.

40. The method of claim 38 wherein the sealant is an organic polymer selected from the group of polytetrafluoroethylene (PTFE), tetrafluoroethylene-perfluorovinyl ethers copolymers, fluorinated ethylene-propylene copolymers, low density polyethylene, poly ether sulfone, polyimide, and epoxy resins.

41. The coating of claim 1 wherein the solid content of the ceramic liquid precursor is a solid component of a ceramic sol.

42. The coating of claim 7 wherein the sealant comprises:

(a) an inorganic material derived from a liquid ceramic precursor, the ceramic precursor being selected from the group of sodium borate, boric acid, mixed borophosphates, and, mixtures of

ceramic sols and silica sols sodium borate, boric acid, and mixed borophosphates; and

(b) an organic polymer containing at least one resin selected from the group of polytetrafluoroethylene, tetrafluoroethylene-perfluorovinyl ethers copolymers, fluorinated ethylene-propylene copolymers, low density polyethylene, poly ether sulfone, polyimide, and epoxy resins.